

REMARKS

Summary of the Office Action

The drawings stand objected to because Figure 12 allegedly should be designated by a legend such as "Prior Art." Corrected drawings are required.

Claim 1 stands rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by Schwarzrock et al (U.S. Patent No. 6,605,828) (hereinafter "Schwarzrock").

Claim 2 stands rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Schwarzrock in view of Hara et al. (U.S. Patent No. 6,828,657) (hereinafter "Hara").

Claims 1-2 stand provisionally rejected under the judicially created doctrine of non statutory obviousness-type double patenting as being unpatentable over claims 1-3 of co-pending application no. 10/573,467 (U.S. Pub. No. 2007/0272997) in view of Schwarzrock.

Summary of the Response to the Office Action

Applicants have amended independent claim 1 and dependent claim 2, and added new dependent claims 6 and 7, to differently describe embodiments of the disclosure of the instant application and/or improve the form of the claims. Accordingly, claims 1-7 remain currently pending with claims 1-2 and 6-7 currently under consideration.

Objection to the Drawings

The drawings stand objected to because Figure 12 allegedly should be designated by a legend such as "Prior Art." Corrected drawings are required. In the Submission of Replacement Drawing Sheets filed concurrently herewith, Applicants have amended the drawings by labeling Fig. 12 as "Prior Art" in response to the drawing objection at page 3 of the Office Action.

Accordingly, Applicants respectfully request that the objection to the drawings, and the associated requirement for corrected drawings, be withdrawn.

Double Patenting Rejection

Claims 1-2 stand provisionally rejected under the judicially created doctrine of non statutory obviousness-type double patenting as being unpatentable over claims 1-3 of co-pending application no. 10/573,467 (U.S. Pub. No. 2007/0272997) in view of Schwarzrock. Applicants respectfully submit that independent claim 1 in this application specifically defines the “wettability” as one of the characteristics of the invention. On the other hand, the claims in the related application 10/573,467 do not define such subject matter to any extent. As a result, Applicants respectfully submit that the claims in these two applications are patentably distinct from each other. Accordingly, Applicants request that the double patenting rejection be withdrawn.

Applicants note that a double patenting rejection was included in an Office Action dated November 26, 2008 in related U.S. patent application no. 10/573,469 (“the ‘469 application”) that applied claims of the instant U.S. patent application no. 10/573,468 against claims of the ‘469 application. A copy of this Office Action dated November 26, 2008 from the related ‘469 application was submitted with an Information Disclosure Statement previously filed in this application on February 3, 2009.

Rejections under 35 U.S.C. §§ 102(b) and 103(a)

Claim 1 stands rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by Schwarzrock. Claim 2 stands rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable

over Schwarzrock in view of Hara. Applicants have amended independent claim 1 and dependent claim 2 to differently describe embodiments of the disclosure of the instant application and/or improve the form of the claims. To the extent that these rejections might be deemed to still apply to the claims as newly-amended, the rejections are respectfully traversed for at least the following reasons.

Independent claim 1 of the instant application has been newly-amended to describe an advantageous combination of features of back-illuminated semiconductor device that includes a semiconductor substrate (10, for example), having a photodetecting unit formed on one surface, a recess, opposing the photodetecting unit, of another surface, an outer edge (15, for example) surrounding the recess (14, for example), and first electrodes (16, for example) disposed on the one surface at the outer edge and electrically connected to the photodetecting unit; a wiring substrate (20, for example), disposed to oppose the one surface side of the semiconductor substrate and having second electrodes (22, for example) connected via conductive bumps (30, for example) to the first electrodes; and a resin (32, for example), filling a gap between the wiring substrate (20, for example) and the outer edge with the conductive bumps (30, for example). Newly-amended independent claim 1 of the instant application goes on to describe that the wiring substrate (20, for example) has a first region (26a, for example) and second regions (26b, for example), the first region (26a, for example) surrounding a region opposing the recess and the second regions (26b, for example) extending outward from the first region (26a, for example), wherein the first region and the second regions have lower wettability with respect to the resin than the other regions of the wiring substrate, and the resin (32, for example) surrounds the periphery of the gap between the recess (14, for example) and the wiring substrate (20, for example) except at the second regions (26b, for example) that are portions of the

periphery, thereby spaces not filled with the resin (32, for example) are formed above the second regions (26b, for example) positioned between the semiconductor substrate (10, for example) and the wiring substrate (20, for example).

Also, dependent claim 2 of the instant application has been newly amended to describe that a silicone resin, a polytetrafluoroethylene, or a wax is coated onto the first region (26a, for example) and the second regions (26b, for example) of the wiring substrate.

Applicants respectfully submit that Schwarzrock differs from the advantageous combination of features described in newly-amended independent claim 1 of the instant application at least because Schwarzrock does not disclose a back-illuminated semiconductor device. Applicants respectfully submit that Schwarzrock shows a low wettability region (31) in Fig. 2. However, Applicants note that Schwarzrock does not include the second region (26b) with “low wettability” and extending toward the outward from the first region (26a) as defined in independent claim 1 of the instant application. Applicants note further that Schwarzrock discloses a light emitting and receiving device which is not a back-illuminated semiconductor device arrangement to any extent, as specifically described in newly-amended independent claim 1 of the instant application.

Turning now to the applied secondary reference, with regard to the rejection of dependent claim 2, Applicants respectfully submit that Hara discloses materials for achieving the low “wettability” (col. 6, lines 15-20) as pointed out by the Examiner. In particular, Fig. 8 of Hara shows a control member (108) made of low wettability material. However, Applicants respectfully submit that this portion of Hara merely shows that such materials are known.

On the other hand, Applicants respectfully submit that the invention disclosed in the instant application was developed in order to solve a particular problem that exists in back-illuminated semiconductor device arrangements.

For example, as disclosed in the specification of the instant application:

[0005] However, when the underfill resin fills the gap between the wiring substrate and the thinned portion of the semiconductor substrate as shown in Fig. 12, the thinned portion may crack due to the stress that arises due to a thermal expansion coefficient difference between the underfill resin and the semiconductor substrate in the process of heating or cooling to cure the underfill resin. Even if cracking does not occur, the thinned portion may become distorted by being pulled by the contraction of underfill resin. Such distortion of the thinned portion of the semiconductor substrate may bring about adverse effects on focusing with respect to the photodetecting unit and uniformity and stability of sensitivity of the photodetecting unit during use of the semiconductor device (emphasis added).

[0006] This invention was made to resolve the above issue and an object thereof is to provide a semiconductor device, with which the distortion and cracking of a thinned portion of a semiconductor substrate are prevented to enable high precision focusing with respect to a photodetecting unit and uniformity and stability of high sensitivity of the photodetecting unit to be maintained.

Applicants respectfully submit that in order to solve the problem that exists in back-illuminated semiconductor device arrangements, "air" is used instead of an underfill resin. The underfill resin only covers the periphery of the substrate. Such a structure is made by utilizing a low wettability material (26a). Please see paragraph [0034] of the specification of the instant application, reproduced below.

[0034] Furthermore, by the wettability processing being applied to wiring substrate 20, the wettability with respect to the resin of region 26a, which surrounds the region opposing thinned portion 14, is lowered in comparison to that of other regions (except for regions 26b). Thus, for example, in the process of filling the gap between semiconductor substrate 10 and wiring substrate 20 with the resin using the capillary phenomenon during manufacture of semiconductor device 1, when the resin entering into the gap from the periphery of semiconductor substrate 10 reaches region 26a, the capillary phenomenon does not proceed further and the entry of the resin stops because region 26a is low in wettability. By such a wettability processing being applied to wiring substrate 20, the arrangement, wherein resin 32 fills the gap at which conductive bumps 30 exist, that is, the gap between wiring substrate 20 and outer edge 15 of thinned portion 14 while the gap between wiring substrate 20 and thinned portion 14 at the inner side of region 26a is left unfilled, can be readily realized (emphasis

added).

However, as discussed in paragraph [0010] of the instant application's specification:

[0010] A sealed space may form when the gap between the thinned portion and the wiring substrate is completely surrounded by the resin. In this case, the thinned portion may become distorted due to expansion or contraction of the air inside the sealed space during heating or cooling in the process of curing the resin, etc. In regard to this issue, with the present semiconductor device, the arrangement wherein the resin surrounds the periphery of the gap except at portions of the periphery is provided to prevent the gap from becoming sealed (emphasis added).

Therefore, Applicants respectfully submit that the device disclosed in the instant application requires escape paths for the air inside the space. In other words, Applicants note that there is no resin on the second low wettability material in order to make the air inside the space escape to outside. Applicants respectfully submit that this advantageous structure can avoid cracking of the thinned semiconductor device. In order to achieve this structure, the second low wettability material (26b) is utilized as disclosed in the instant application. Applicants refer, for example, to paragraph [0036] of the specification of the instant application in this regard, reproduced below.

[0036] Moreover, by the wettability processing being applied to wiring substrate 20, the wettability with respect to the resin of regions 26b, which extend outward from region 26a, is lowered in comparison to that of other regions (except for region 26a). Thus, for example, in the process of filling with the resin using the capillary phenomenon as mentioned above, because the progress of the resin stops upon reaching regions 26b, spaces that are not filled with resin 32 are formed above regions 26b. The arrangement, wherein resin 32 surrounds the periphery of the gap between the thinned portion and the wiring substrate except at portions of the periphery, can thus be readily realized (emphasis added).

Applicants respectfully submit that in the arrangement disclosed in Schwarzrock, the surface where a recess is provided is opposite to a surface where a recess of the instant

application's disclosed invention is provided. In other words, Applicants respectfully submit that the recess of Schwarzrock is provided on the side where the bumps are provided. That is, Applicants respectfully submit that Schwarzrock discloses a front-illuminated type light detecting device, and the light receivers (12, 13) detect light from the front side. Applicants respectfully submit that Schwarzrock is not a back-illuminated semiconductor device as described in independent claim 1 of the instant application. In this regard, Applicants respectfully submit that the recess of the semiconductor substrate (100) in Schwarzrock does not receive the light. The semiconductor substrate (100) of Schwarzrock has a recess (102) formed opposite the side where the contact (171) is formed on the glass plate (16). That is, the recess is formed on the bump bonding surface. Applicants respectfully submit that the LED (11) is fixed in the recess and the light receivers (12, 13) are formed on the periphery of the recess. In this regard, both the recess (102) and light receivers (12, 13) are fixed on the same side of the semiconductor substrate, and the light receivers (12, 13) detect light through the glass plate (16).

Applicants respectfully submit that the object of Schwarzrock is to prevent direct light that is incident on the light receiver (12, 13) from an LED (11) that emits light toward the glass plate (16). In order to prevent the direct incidence along these lines, a border area (24) is formed as shown in Figs. 1 and 2 in Schwarzrock. The border area (24) fills under filler (20) only between the periphery of the recess and the glass substrate (16).

On the other hand, Applicants respectfully submit that the recess of the invention disclosed in the instant application is formed in a manner that is opposite that of the arrangement in Schwarzrock. That is, Applicants respectfully submit that the photodetecting unit is formed just at the bottom of the recess opposing the wiring substrate. Accordingly, the photodetecting unit detects light that is incident in the recess. In other words Applicants respectfully submit that

the device disclosed in the instant application is a back-illuminated semiconductor device, as specifically described in the combination of features of newly-amended independent claim 1 of the instant application.

Applicants respectfully submit that in the arrangement disclosed in Schwarzrock in order to stop the flow of resin, the low wettability material (31) is provided. However, Applicants respectfully submit that the low wettability material is provided in Schwarzrock on a second region that corresponds to the second region (26b) of the invention disclosed in the instant application. Applicants note further that in the arrangement disclosed in Schwarzrock, the border area (24) is formed by providing a low-wettability surface area (31) on the glass plate (16) so as to stop the flow of the under filler (20) at the edge of the area (31) into the recess of the semiconductor substrate (100). In this configuration, the low wettability surface area (31) is provided only on a region surrounding the recess of the semiconductor substrate (100).

Therefore, Applicants respectfully submit that the arrangement disclosed in Schwarzrock includes no second region (26b) such as that included in the disclosure of the invention of the instant application. In other words, the low wettability surface area (31) does not extend from the region around the recess toward the outside of semiconductor substrate (100). As a result, Applicants respectfully submit that there is no path for air between the recess of the substrate (100) and the glass plate (16) in the arrangement disclosed in Schwarzrock. Accordingly, and importantly, the distortion based on the air expansion or contraction cannot be suppressed in such an arrangement.

Turning again to the applied secondary reference to Hara with regard to the rejection of dependent claim 2, Applicants respectfully submit that Hara involves a technology that lowers the wettability of the position control member (108) to the adhesive (109) in a divergent

technology field from that of the instant application's disclosed invention. Applicants respectfully submit that, in the technology field disclosed in Hara, in order to print an active element (103) such as a TFT on the substrate (107), a plurality of position control members (108) are provided on the substrate (107). Applicants respectfully submit that the active element (103) is fixed on the substrate (107), via the adhesive (109), and between the position control members (108).

Accordingly, Applicants respectfully submit that, in Hara, there is no equivalent member to the thinned portion (recess) as specifically described in the instant application. Accordingly, Applicants respectfully submit that Hara would provide no teaching, or even a suggestion, of how to resolve the above-discussed issue of distortion of the thinned portion.

Accordingly, Applicants respectfully assert that the rejections under 35 U.S.C. §§ 102(e) and 103(a) should be withdrawn because neither Schwarzrock nor Hara, whether taken separately or in combination with each other, teach or suggest each feature of claims 1 or 2 of the instant application, as newly-amended, for at least the reasons discussed previously. Applicants respectfully submit that the features of these claims could not be derived from the disclosures of Schwarzrock and Hara. Also, Applicants have concluded that a person having ordinary skill in the relevant art could not easily derive the invention described in the claims of the instant application from the disclosures of Schwarzrock and Hara. As pointed out in MPEP § 2131, "[t]o anticipate a claim, the reference must teach every element of the claim." Thus, "[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. Verdegaal Bros. v. Union Oil Co. Of California, 2 USPQ 2d 1051, 1053 (Fed. Cir. 1987)." Also, MPEP § 2143.03 instructs that

“‘[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art.’ In re Wilson, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970).”

Furthermore, Applicants respectfully submits that the newly-added dependent claims 6 and 7 are allowable at least because of their dependence from newly-amended independent claim 1, and the reasons discussed previously. Also, as withdrawn dependent claim 4 depends on newly-amended independent claim 1, rejoinder of at least dependent claim 4 is respectfully requested.

CONCLUSION

In view of the foregoing, Applicants submit that the pending claims are in condition for allowance, and respectfully request reconsideration and timely allowance of the pending claims. Should the Examiner feel that there are any issues outstanding after consideration of this response; the Examiner is invited to contact Applicants' undersigned representative to expedite prosecution. A favorable action is awaited.

EXCEPT for issue fees payable under 37 C.F.R. § 1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 C.F.R. § 1.16 and 1.17 which may be required, including

any required extension of time fees, or credit any overpayment to Deposit Account No. 50-0573.

This paragraph is intended to be a **CONSTRUCTIVE PETITION FOR EXTENSION OF TIME** in accordance with 37 C.F.R. § 1.136(a)(3).

Respectfully submitted,

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